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USS Carl Vinson SDMS: Final Report

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Figure 6. Report Documentation Page.

CONTENTS

ILLUSTRATIONS

1. Introduction

This is the final report of the Transfer of an SDMS to the USS Carl Vinson under the previously referenced contract. It describes the USS Carl Vinson application of Computer Corporation of America's (CCA's) Spatial Data Management System (SDMS) -- a unique, user interface that provides a simple and uniform means of accessing different kinds of computerized information. Work under the referenced contract consists of the design and partial implementation of this application.

SDMS is a computer-based tool that uses graphical symbols to convey information. SDMS merges the visual power of symbols with the information-handling facilities of a conventional database management system (DBMS). It provides a highly effective means for people who are not data processing professionals to organize and access a database.

Spatial data management is a technique for organizing and retrieving information by representing and positioning it graphically. Data are viewed through color displays. The displays show flat data surfaces on which pictorial representations of the data are arranged. The collection of all the data surfaces is called the graphical data space (GDS). The GDS consists of all the pictures that the user can access. SDMS automatically creates these pictures from data stored by the DBMS.

The user can traverse the data surfaces or "zoom into" an image to obtain greater detail. This approach permits many types of questions to be answered without requiring the use of a keyboard. A conventional query language is also provided.

Spatial data management is motivated by the needs of a growing community of people who want to access information through a DBMS but are not trained in the use of such systems. A database viewed through SDMS is more accessible and its structure is more apparent than when viewed through a conventional DBMS. Users of conventional DBMSs can access data only by asking questions in a formal query language. In contrast, users of SDMS benefit from the ability to access computer-resident information while retaining a familiar, visual orientation.

By presenting information in a natural, spatial framework, SDMS encourages browsing and requires less prior knowledge of the contents and structure of the database. A user can retrieve information without having to specify it precisely or to know exactly where in the database it is stored. A great deal of information of different types can be easily organized, located, and handled.

In July 1982, an SDMS was installed in the Intelligence Center of the USS Carl Vinson (CVN 70), the newest Nimitz-class, nuclear aircraft carrier. This system is being used to access information about allied and Soviet platforms, including their positions, characteristics, and armaments.

The rest of this document is divided into the following sections:

- Section 2 contains a detailed example of how to use SDMS to access data from the USS Carl Vinson SDMS database.
- Section 3 describes the system environment.
- Section 4 is the bibliography.
- Section 5 is a glossary of SDMS terms.
- Section 6 is a list of acronyms and abbreviations.

2. Using SDMS

This section contains an example of using SDMS as an interface to the USS Carl Vinson database of information about platforms. At the SDMS user station (Figure 2.1), the user interacts with the database through a set of three color displays. The left-hand display screen is used to show a high-level view (or world view) of the data available to the user (Figure 2.2). When the user first starts SDMS, this world view shows all the categories of data that can be accessed through the system. In the USS Carl Vinson application, this TOP level view consists of a map of the world and several colored rectangles containing symbols of platforms and armaments. The colored rectangles and the map are called icons. They represent the following major groupings of information: Russian SHIPS, SUBMARINES, AIRCRAFT, MISSILES, and MINES; ALLIES; mission PROFILES; the Ship's Inertial Navigation System (SINS); and a map display of platform positions. There are two other rectangles: SCRATCH refers to a graphical scratch pad area, and TEMPLATES contains the graphical templates used to create all the other pictures that the system displays.(1)

A highlighted rectangle indicates the user's position on the world view. The user can change position by pressing a joystick (pictured in Figure 2.1). Pressing the joystick in any direction causes the highlighted rectangle to move in that direction over the data surface. Alternately, the user can move quickly to a particular location on the data surface by touching that location on the world view.(2)

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(1) A special language is used to describe to SDMS the appearance and position of icons: the Icon Class Description Language (ICDL). ICDL is described in detail in the ICDL Reference Manual that is part part of the USS Carl Vinson SDMS documentation.

(2) A third way the user can move to a location on the data surface is by using the puck and data tablet.

Figure 2.1 Multi-Media User Station

A more detailed view of a portion of the data surface is displayed simultaneously on the main display screen located in the center of the user station. The center screen shows the same portion of the data surface that is shown within the highlighted rectangle on the left screen.

The simultaneous presentation of a world view and a more detailed view of the data surface prevents the user from getting lost in the database. It also helps in finding a region of interest in a very large database.

There are three kinds of data displays available to the user:

1. Information Space (Ispace) Display

   Each rectangular icon on the TOP level world view acts as a trap door to a collection of information known as an Information Space, or Ispace.

2. Menu Display

   The menu display allows the user to request detailed information about each platform.

3. Map Display

   The map display presents platform icons superimposed on a background of maps. It is represented by the map on the TOP Ispace.

Each display is described in the following sections.

2.1 Ispace Display

Much of the data the user views is structured into groupings called Information spaces (Ispaces). The transition points between Ispaces are called ports. The world view shown in Figure 2.2 is the TOP Ispace. Each rectangular icon on this world view is a port (Figure 2.3). The SHIPS icon is a typical port; it allows the user to access the (Russian) SHIPS Ispace. The SINS port allows the user to access a SINS information display. When this port is selected, alphanumeric data about the USS Carl Vinson will be displayed (for instance, latitude and longitude, speed, and direction).

Each Ispace can contain multiple levels of detail. Each level of detail is called an image plane (iplane). The relationships between Ispaces, ports, and iplanes are shown in Figure 2.4.

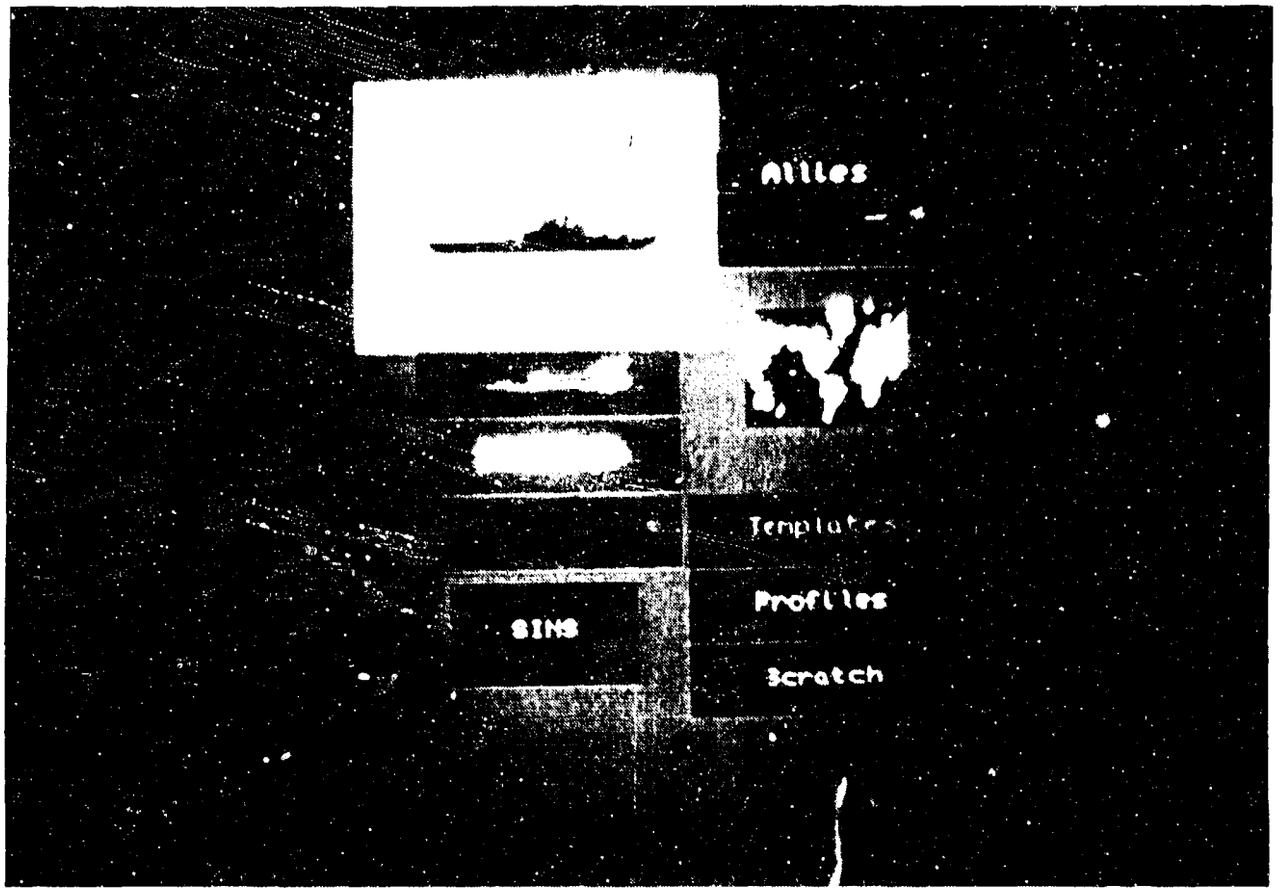

Figure 2.2 USS Carl Vinson SDMS -- TOP World View (Left-Hand Screen)

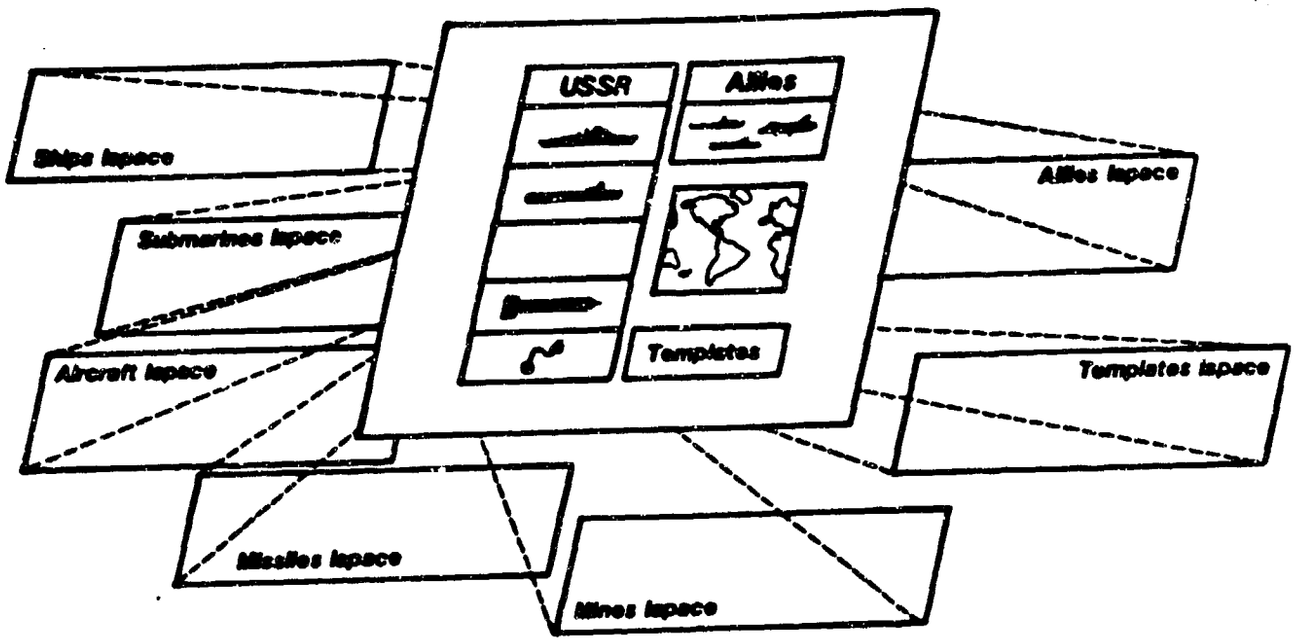

Figure 2.3 Ports into Information Spaces

In this example, the user begins by centering the SHIPS port on the center screen (Figure 2.5). A clockwise twist of the joystick results in "zooming into" the SHIPS Ispace. While the joystick is twisted, the images on the screen become more and more magnified until the user "pops through" the port into the new Ispace. This takes several seconds.

When the user enters the SHIPS Ispace, its world view appears on the left-hand screen (Figure 2.6). The SHIPS world view shows an icon for each ship class that is represented in the database. The icons are clustered by category. The center screen shows the next most detailed view (Figure 2.7).

Whenever the user enters an Ispace, iplane 0 appears on the left-hand screen and iplane 1, on the center screen. Iplane 0 is always the world view: a single level of detail of an Ispace. It remains on the left-hand screen while the user remains in that Ispace.

In the USS Carl Vinson example, each major Ispace consists of two iplanes. For each Ispace, iplane 0 contains icons that consist of pictograms but no textual data. Iplane 1 contains more detailed icons and indicates a ship's or submarine's class and type, an aircraft's name

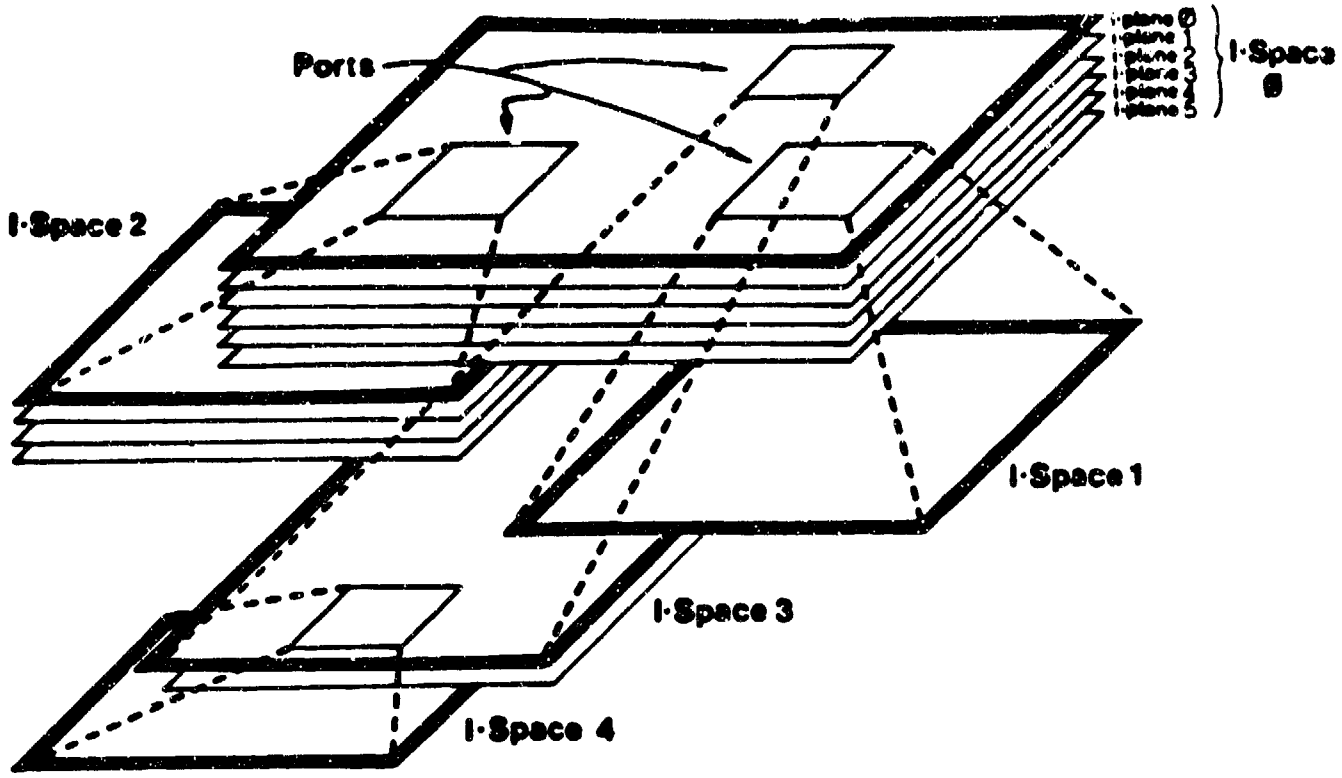

Figure 2.4 Nesting of Information Spaces Through Ports

and nomenclature, a missile's or mine's name and NATO designator, and an ally platform's type and category. There is an icon for each ship, submarine, and aircraft class, and for each missile and mine NATO designator.

An alternate method of entering an Ispace is via a hierarchy map that depicts all Ispaces in the SDMS GDS. To view this map, the user presses the SELECT button on the base of the joystick. The hierarchy map will appear on the left-hand screen (Figure 2.8). A line from one Ispace icon to another Ispace icon below it means that there is a port from the "upper" Ispace to the "lower" Ispace. The user can either touch an icon on the hierarchy map to enter the Ispace that the icon represents or press the SELECT button again to return to the original world view.

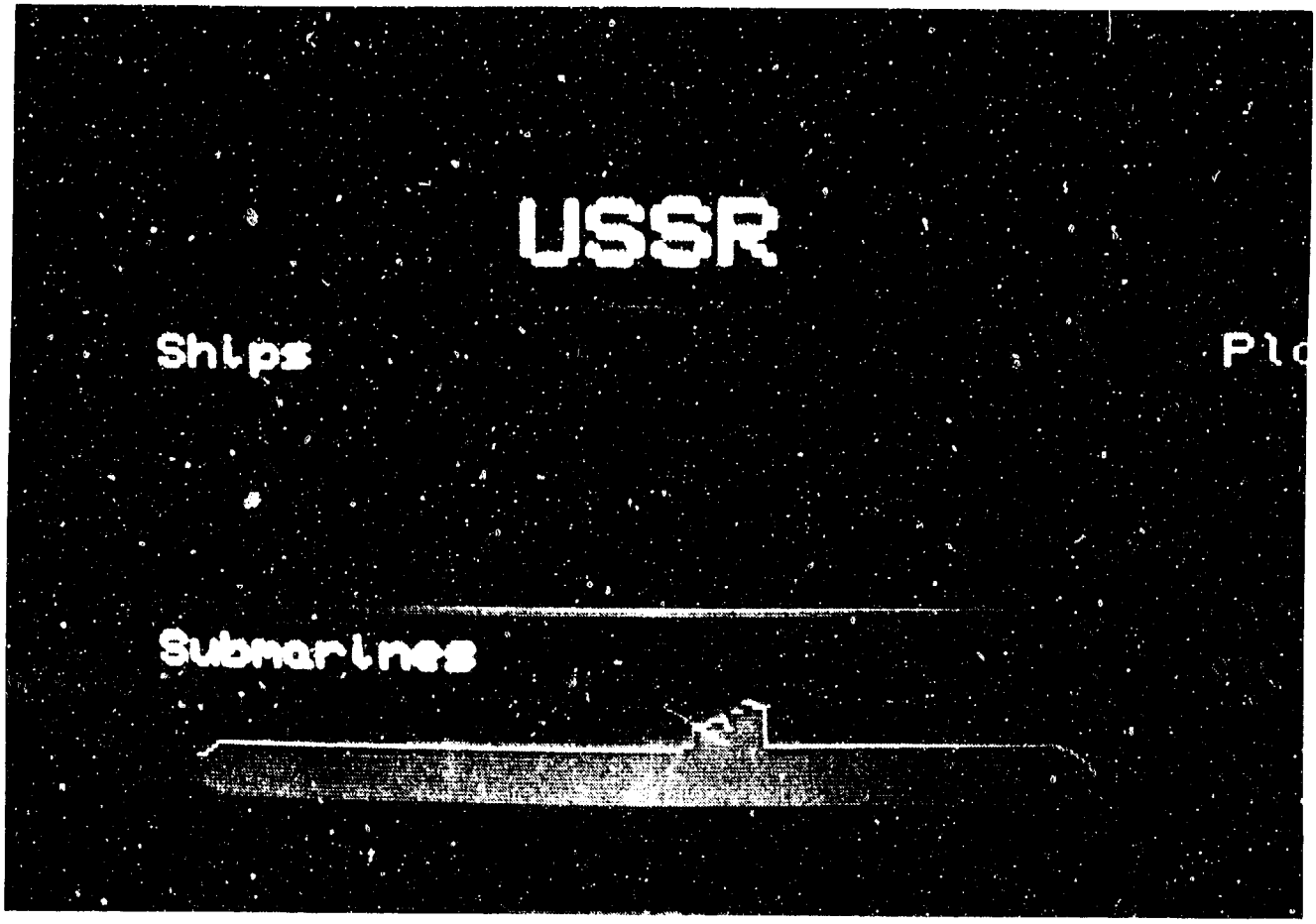

Figure 2.5 User Centers on SHIPS Port and Prepares to Zoom In (Center Screen)

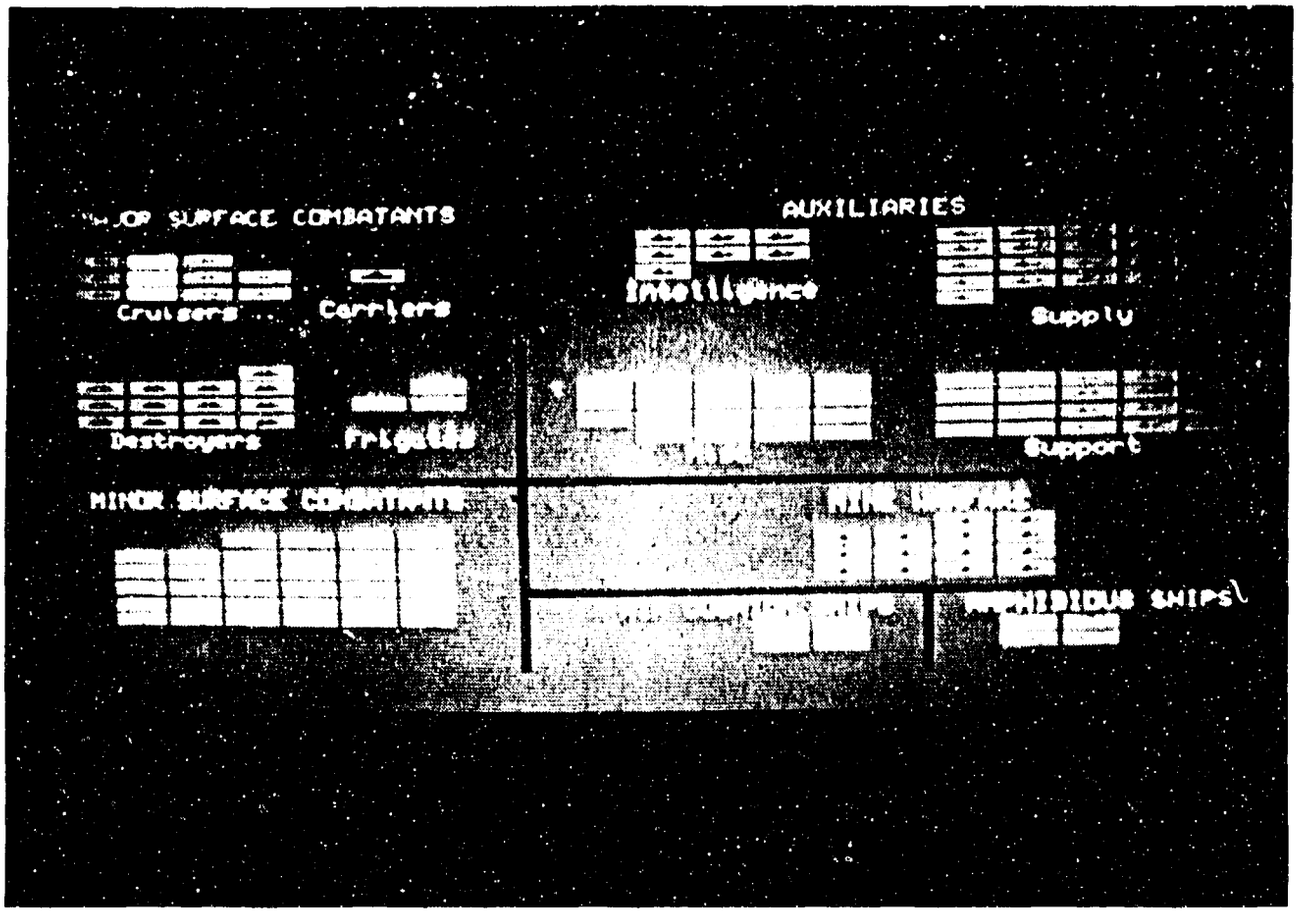

Figure 2.6 World View (Iplane 0) of SHIPS Ispace
(Left-Hand Screen)

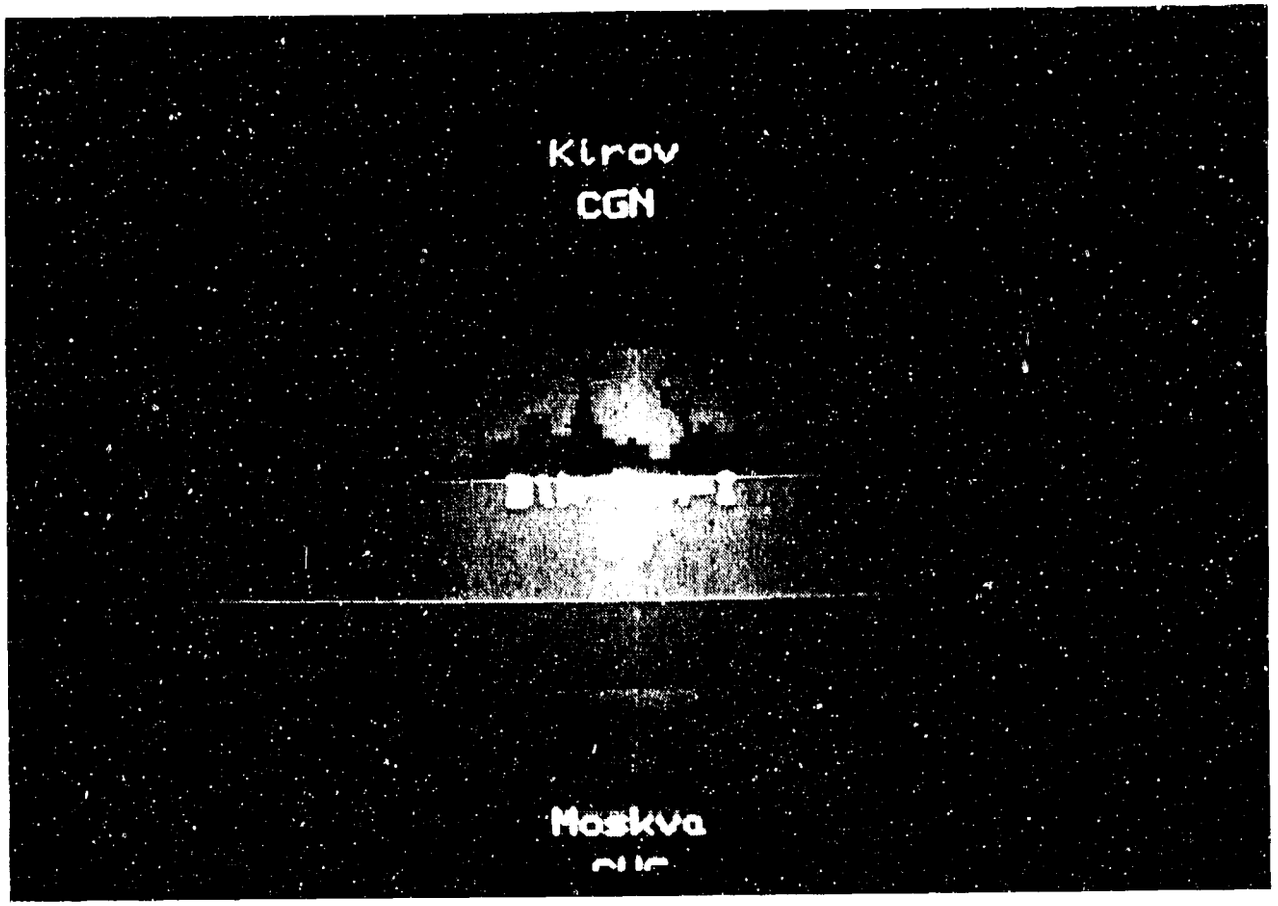

Figure 2.7 Iplane 1 of the SHIPS Ispace (Center Screen)

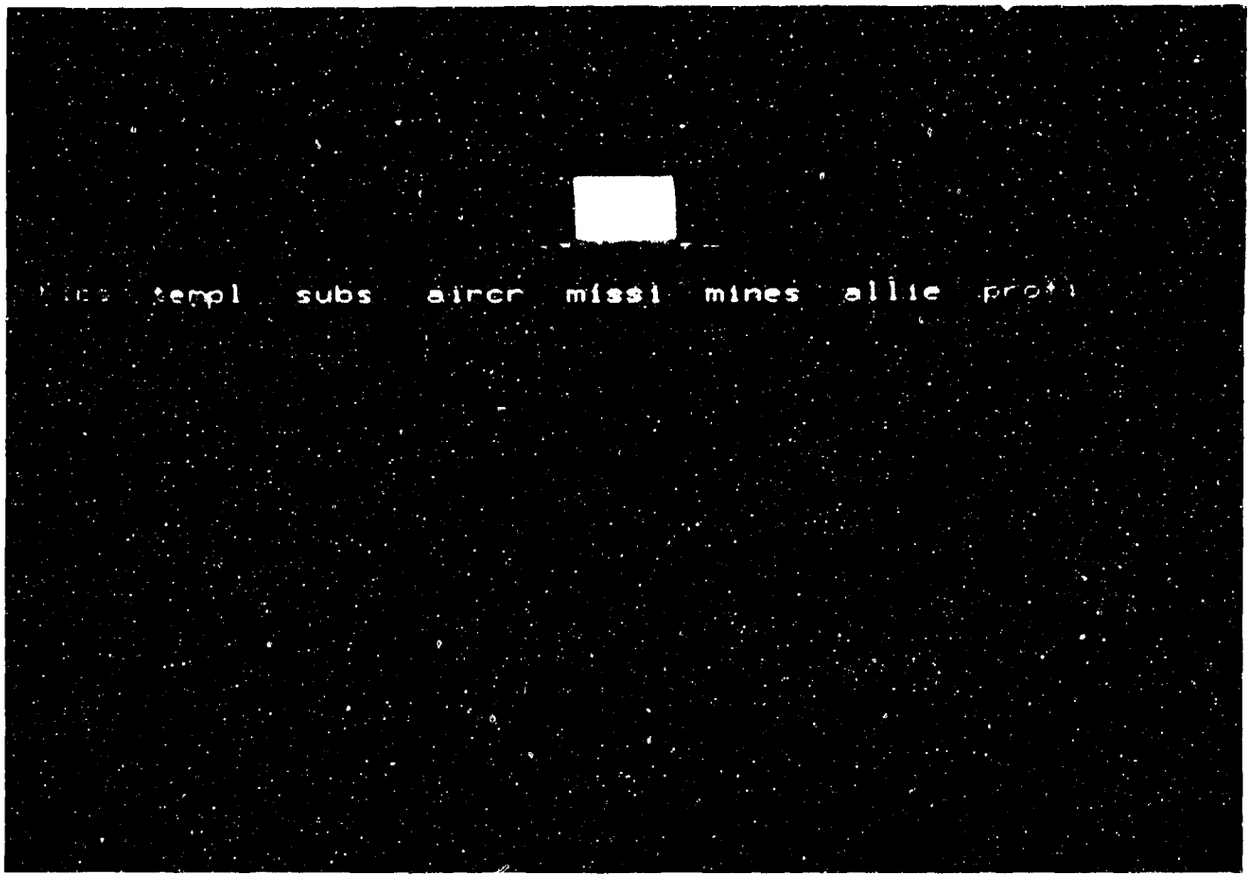

Figure 2.8 Hierarchy Map (Left-Hand Screen)

SDMS ensures that the graphical Ispace display reflects the current values in the database. When the database is updated, SDMS creates graphical representations of the new data values. For example, to update the database by adding a new ship class, the user would employ a standard DBMS query language. SDMS would automatically update the display by adding an icon to represent the new ship class.

While the user views an Ispace, SDMS can interpret conventional database queries written in SQUEL (Spatial QUEry Language), the SDMS query and command language. For example, the user could issue a query requesting the system to locate all ship classes capable of travelling at a certain speed and to cause the icons for these ship classes to blink. SDMS would search the DBMS for all of the specified ship classes. For each such ship class, the corresponding icon would blink. The user could then point to a blinking ship icon on the world view to examine it individually, or traverse the data surface to view the blinking ship icons in greater detail.(3)

In this example, the user examines the ship icons by moving across the iplane (i.e., pressing the joystick). To mark one of the ships for more detailed examination later, the user touches the right-hand screen to activate PAINT, an interactive system for creating and manipulating pictures on the screen. PAINT allows the user to add pictures to the data surface via a data tablet.(4) Editing commands are selected by touching them on the right-hand screen. In Figure 2.9, the user has selected "electronic ink" and marked the appropriate ship icon. This annotation can be automatically miniaturized onto the less detailed iplanes.(5)

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(3) SQUEL is described in detail in the SQUEL Reference Manual that is part of the USS Carl Vinson SDMS documentation. See the bibliography of this report.

(4) A data tablet looks like a small desk top and is pictured in Figure 2.1. It is used in conjunction with a pointer, called a puck, to locate a point on a display screen.

(5) PAINT is described in detail in the PAINT Reference Manual that is part of the USS Carl Vinson SDMS documentation. See the bibliography of this report.

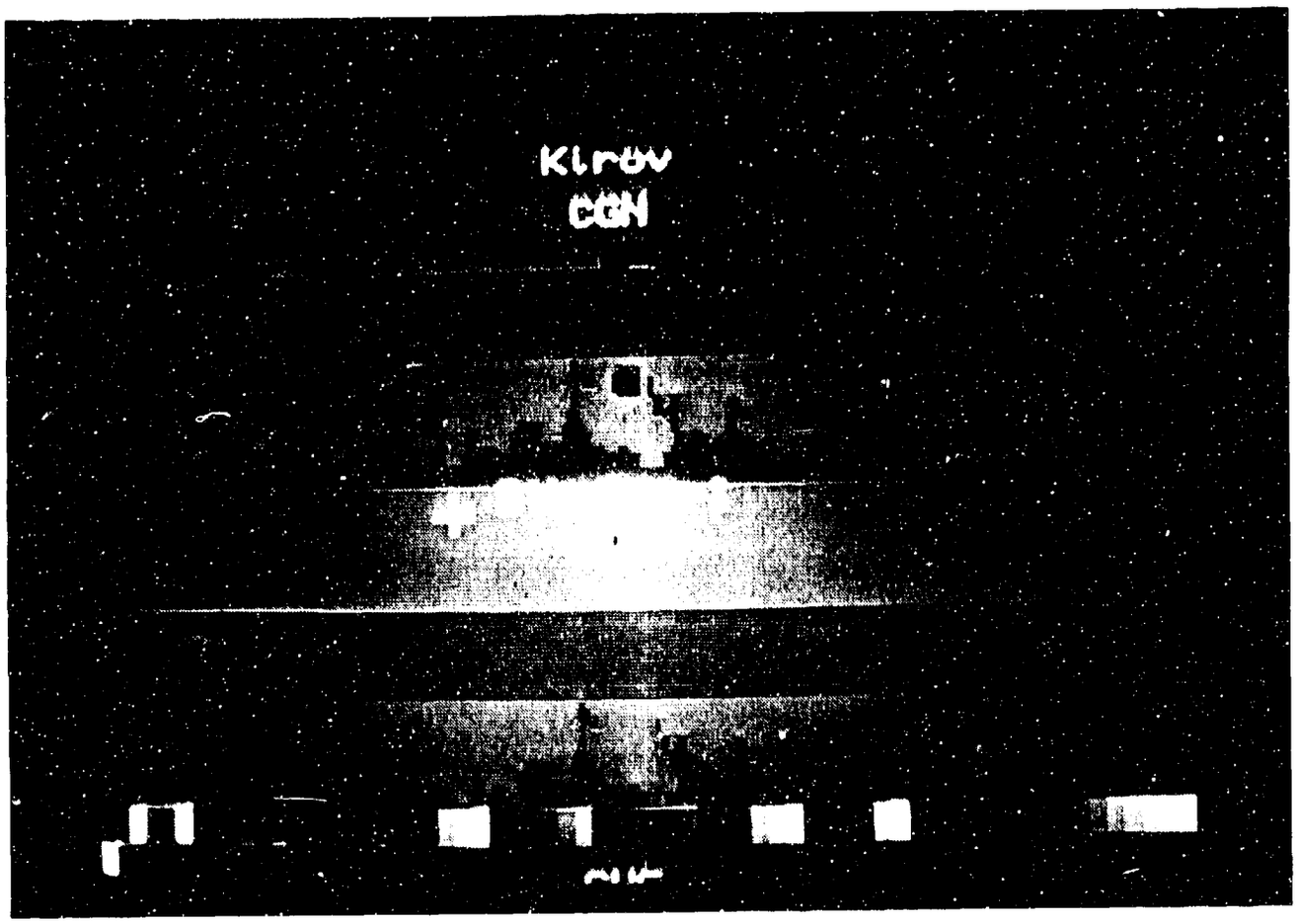

Figure 2.9 Annotating the Data Surface with the Graphical Editor (Center Screen)

To exit the SHIPS Ispace, the user twists the joystick counterclockwise. In general, this results in zooming out of the current iplane, back to the previous, less detailed iplane. In this case, since the only less detailed iplane is the world view, and since that is already displayed (on the left-hand screen), the user will zoom out of the Ispace and reappear at the TOP level.(6) The other Ispaces (SUBMARINES, AIRCRAFT, MISSILES, MINES, and ALLIES) can be examined just as the SHIPS Ispace was examined.

2.2 Menu Display

To obtain more information while viewing an Ispace, the user centers an icon on the center screen and twists the joystick clockwise to zoom into a menu about that Ispace's platforms. For instance, if a ship icon is centered on the center screen and the joystick is twisted clockwise, the user will zoom into a menu about ships. The icon on the center screen will be replaced by a photograph of the platform that the icon represented. The menu will appear on the right-hand screen (Figure 2.10). Menus are available for the following object types: SHIPS, SUBMARINES, AIRCRAFT, MISSILES, and MINES.

The menu display within an Ispace allows the user to access a great deal of information about individual ship classes, submarine classes, aircraft, missiles, and mines. The user can touch any menu category on the screen to obtain additional information about that category. The selected category is highlighted on the menu. (When the user enters the menu display, the PHOTOGRAPHS category is highlighted.) The additional information appears on the center screen. (When the user enters the menu display, photographs of the selected platform appear on the center screen.) The display on the left-hand screen keeps track of each category selected in a menu session, to prevent getting lost in the menu and to assist in selectively backing out of the menu.

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(6) The user returns to the TOP level only if the Ispace was entered from the TOP level. If it was entered through the map display (see Section 2.3), the user will return to the map display.

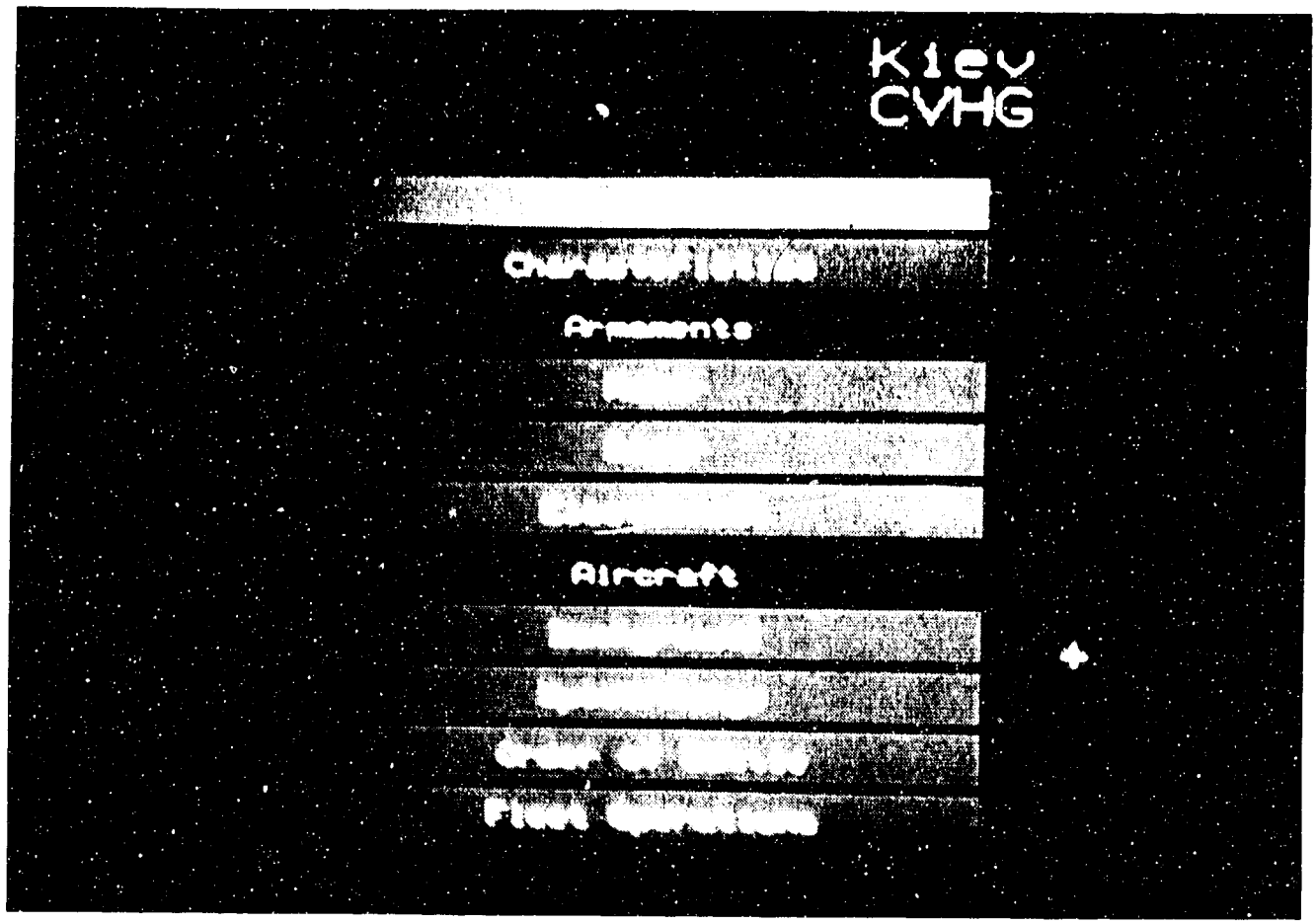

Figure 2.10 Menu for SHIPS Ispace (Right-Hand Screen)

The information categories on the menu are color-coded as follows:

- The PHOTOGRAPHS category is light gray.
- Categories that contain textual information are gold.
- Categories that activate programs are dark gray.
- Categories that contain key fields(7) are dark red.

When the user selects the PHOTOGRAPHS category, the system displays on the center screen photographs of the current object (ship, submarine, aircraft, missile, or mine). These photographs are taken from the attached videodisk. The number of photographs available for the current object is indicated by the number of marks beside the PHOTOGRAPHS item on the object's menu. The mark indicating the currently displayed photograph is highlighted on the menu. To view successive photographs or to back up to a previous photograph, the user touches one of the arrows on the menu screen. If the downward-pointing arrow is touched while the last photograph is being viewed, the user will move down to the next menu item: CHARACTERISTICS.

Menu categories can activate computer programs. For example, in the menus for missiles and for mines, the MISSION PROFILE category activates a program. The program causes a previously saved mission profile for the missile or mine that is being viewed to be displayed on the center screen.(8)

Some categories contain data that can be used to move from one object type to another; these pieces of data are called key fields and are displayed in red. For instance, the data displayed under the AIRCRAFT category of the SHIPS menu may contain key fields that are the identifiers(9) of the aircraft carried by the ship that is being examined. If one of these key fields, aircraft identifiers, is touched, the system will display a new menu that will enable the user to view information about that

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(7) Key fields are defined later in this section.

(8) Mission profiles can be saved by using the SAVE PROFILE command in PAINT, SDMS's graphical editing system.

(9) These identifiers are the key attributes in the relation corresponding to the object type being displayed.

aircraft. The aircraft menu display will be the same as if the user had entered the menu display by zooming into that aircraft icon from the AIRCRAFT Ispace.

The display on the left-hand screen shows each object that the user has selected (and has not backed out of) in the current menu session. For example, Figure 2.11 shows the left-hand display after the user has completed the following sequence of menu display actions:

1. Enter the menu display through the KIEV carrier.

2. Select the ARMAMENTS menu category under KIEV. This causes the system to display information about the KIEV's armaments.

3. Select the Gecko SA-N-4 key field displayed as part of the armaments information about the KIEV. This causes the system to display a new menu (about missiles) for the Gecko.

4. Select the ASSOCIATED PLATFORMS menu category under Gecko. This causes the system to display a list of the platforms that have Gecko SA-N-4 missiles. The KIEV is on this list.

5. Select the KIROV key field from the list of associated platforms for Gecko SA-N-4 missiles. This causes the system to display a ship menu again, this time for the KIROV cruiser.

6. Select the AIRCRAFT category from the ship menu for the KIROV.

The user can exit or back out of the menu display in several ways. To back out of the menu display one level at a time (until the Ispace is reached), the user either twists the joystick counterclockwise or touches the BACK menu item. To back out to a particular level shown on the left-hand screen, the user touches that level on the left-hand screen. Menu levels are removed from the left-hand display as the user backs out of them. By touching the ENTRY DATA SURFACE category on the top of the left-hand display, the user will exit the menu display and return to the Ispace display.

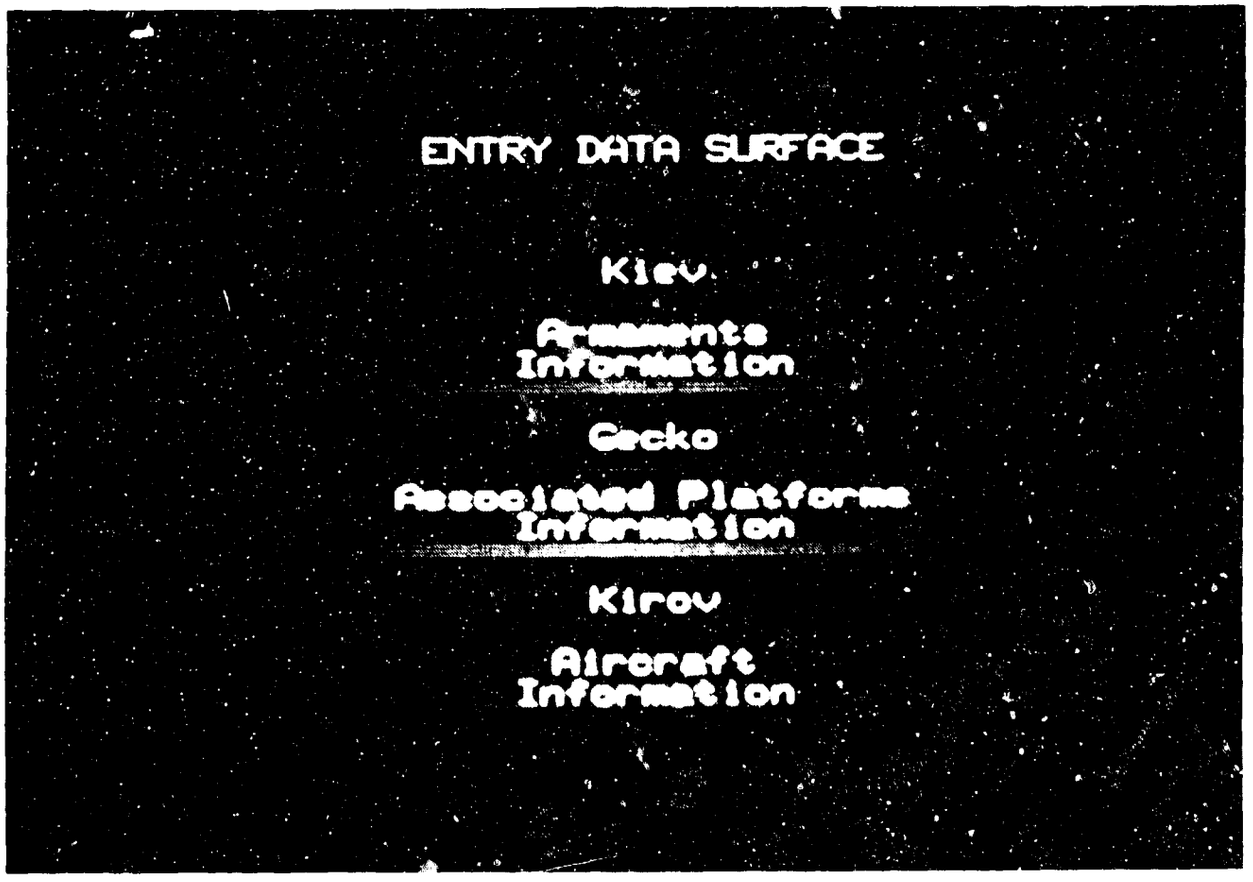

Figure 2.11 Multiple Levels of Ispace Menu Interaction (Left-Hand Screen)

2.3 Map Display

To examine the map display, the user zooms into the map on the TOP world view by centering the map on the screen and twisting the joystick clockwise. The map display's world view reveals the location of each U.S. and Russian platform by means of dots on a map of the world (Figure 2.12). The data that determine the placement of these dots comes from UTIPS (Upgraded Tactical Information Processing System). The displays normally show deterministic positions, which are updated sporadically by UTIPS. Probabilistic positions also can be displayed. Usually, these positions are updated much more frequently. An updated probabilistic position for one platform is available approximately every five seconds.

The map display on the center screen (Figure 2.13) consists of map images retrieved from a videodisk. For each platform within the range of the portion of the map displayed on the screen, the appropriate NTDS symbol and either platform name (if available) or PIF code are superimposed on the map at the platform's last recorded position. The symbols are color-coded to indicate whether they represent friendly (light blue), hostile (red), or unknown (white) platforms

The user can move across the map by pressing the joystick. Because discrete videodisk images are being displayed, the screen will jump from one map section to another, rather than scrolling smoothly as with Ispace images. Each jump moves the user one-third of the width or height of the screen. As usual, a highlighted rectangle on the world view screen covers the portion of the world view that is displayed on the center screen.

The menu on the right-hand screen offers the user a variety of options while viewing the map display. These are pictured in Figure 2.14 and described in Figure 2.15. When the user enters the map display, all menu items are shown in red; items that have ON/OFF switches are OFF, and TRACK TYPE is set to DETERMINISTIC. When the user selects an item, it changes to green (ON), and successively touching the item causes it to alternate between being green and red (ON and OFF).

The user can view successively more detailed maps by twisting the joystick clockwise. When a more detailed map is available for only a portion of the world view (and not the entire world view), a white rectangle is shown on the left-hand screen to define the area covered by the more detailed map.

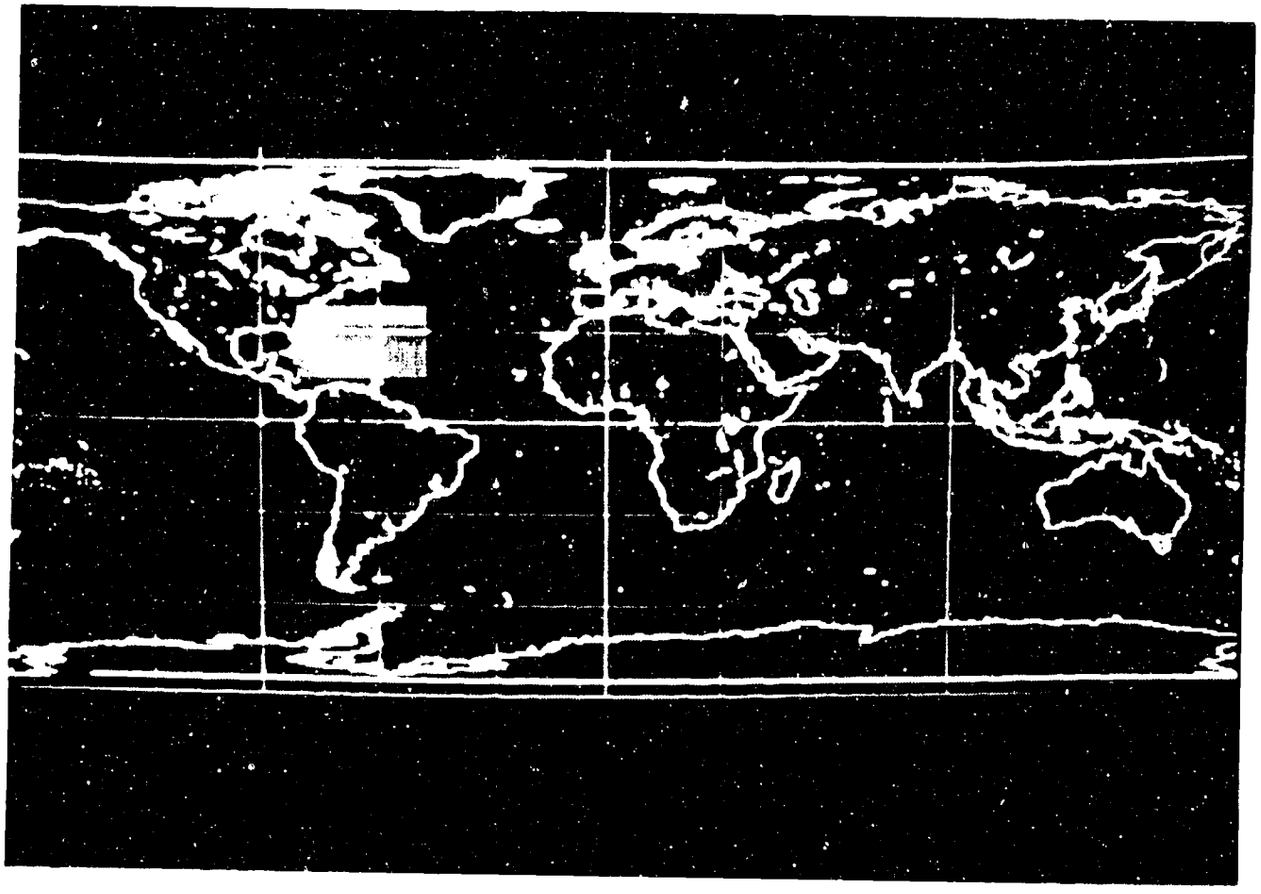

Figure 2.12 World View of Map Display (Left-Hand Screen)

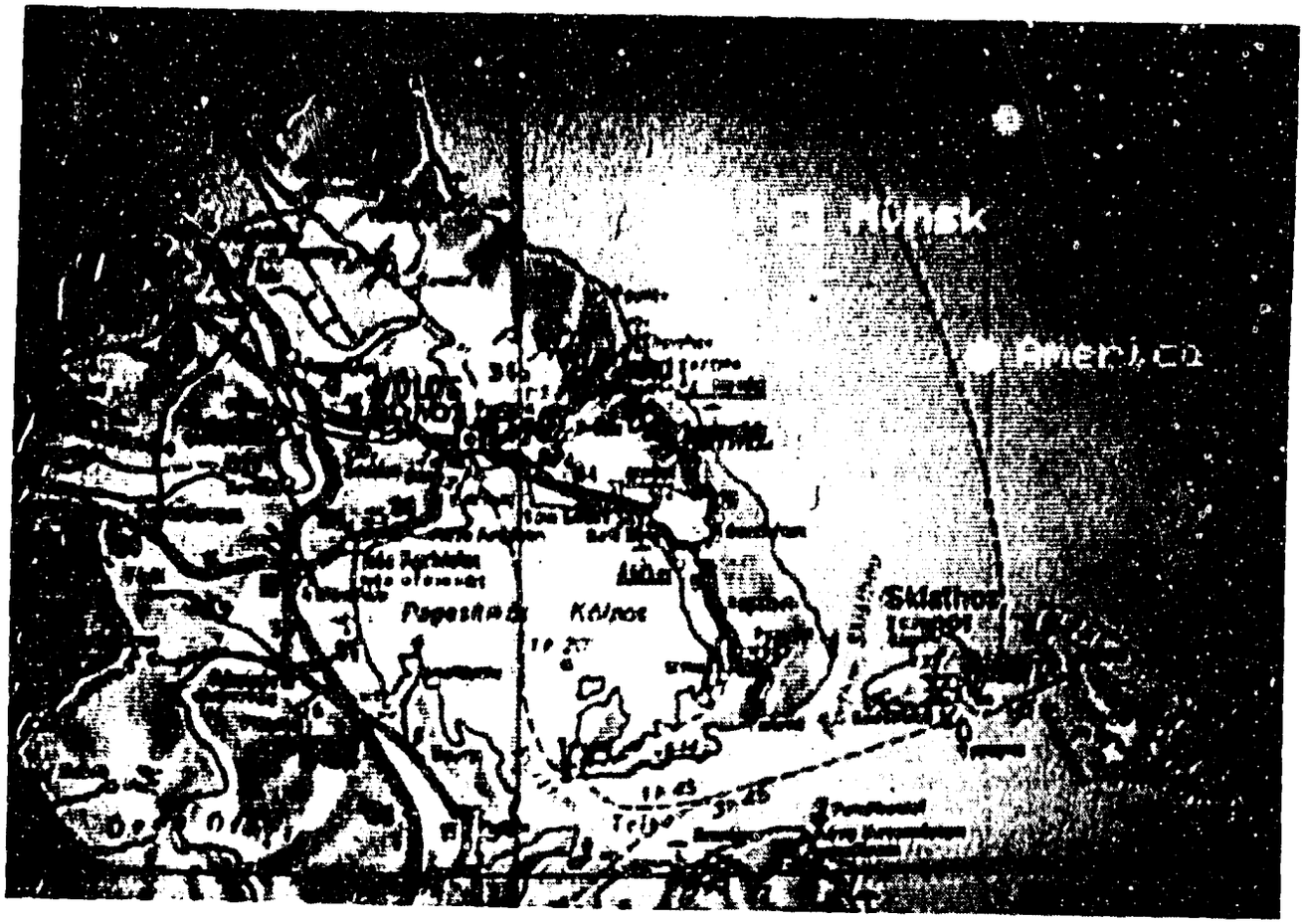

Figure 2.13 Map Display (Center Screen)

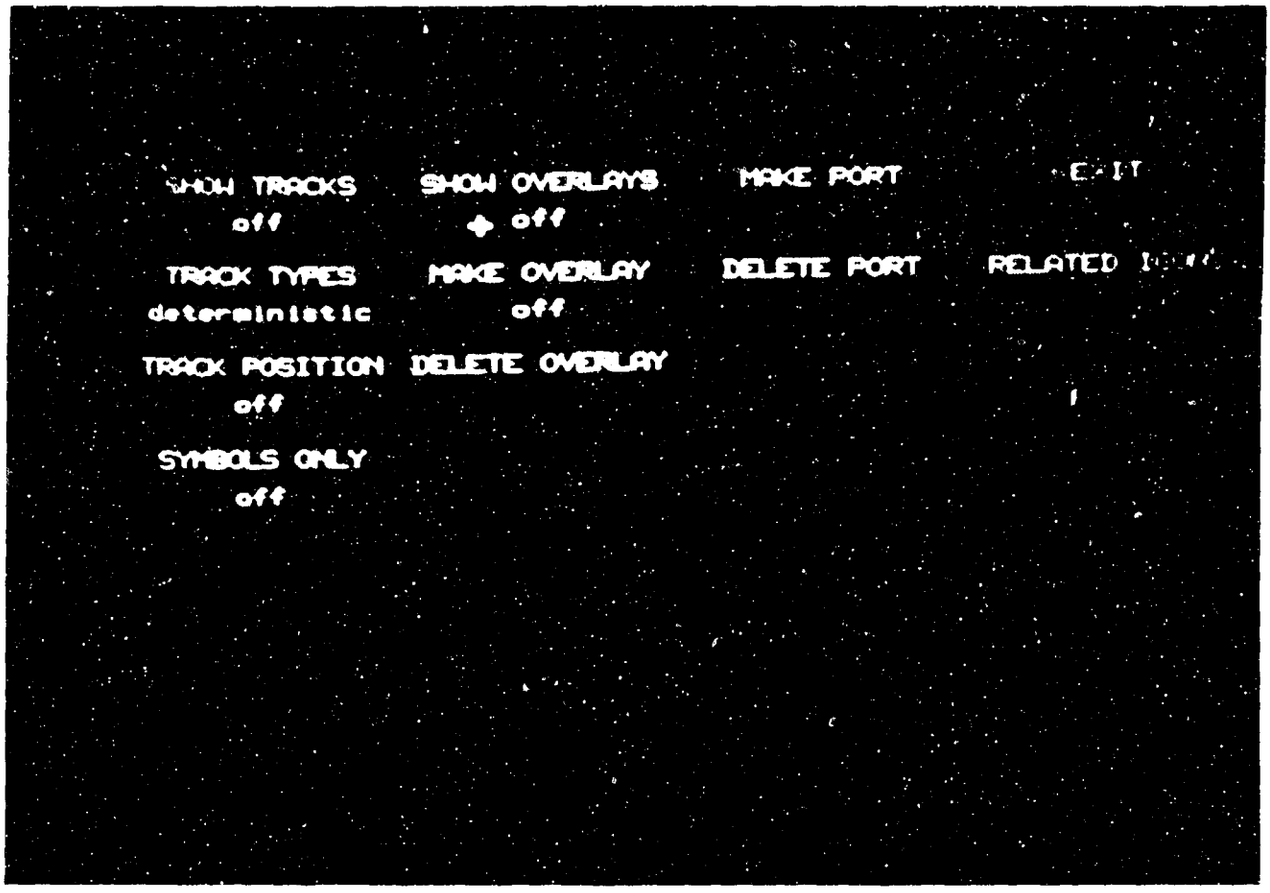

Figure 2.14 Map Display Menu (Right-Hand Screen)

MAP MENU OPTION	EXPLANATION
SHOW TRACKS (OFF/ON)	Show UTIPS tracks superimposed on a map background.
TRACK TYPES (DETERMINISTIC/ PROBABILISTIC)	Select which UTIPS track type to display.
TRACK POSITIONS	Show coordinates (deterministic or probabilistic, whichever was last selected by using TRACK TYPES) of a track that the user points to on the center screen. Coordinates are printed on the bottom of the right-hand (menu) screen.
SYMBOLS ONLY (OFF/ON)	Show only NTDS symbols.
SHOW OVERLAYS (OFF/ON)	Show previously drawn map overlays.
MAKE OVERLAY (OFF/ON)	Enter PAINT (with ICONS mode disabled) to make map overlays; to return to the map display, exit PAINT.
DELETE OVERLAY (OFF/ON)	Delete the overlay associated with the current map frame, if there is any such overlay.
MAKE PORT	Same as MAKE PORT command in PAINT.
DELETE PORT	Same as UNMAKE command in PAINT.
EXIT	Exit map display and go to SDMS TOP level.
RELATED ICONS	Go to the Ispace display that corresponds to the platform type under the cursor (ships, submarines, or aircraft). Twisting the joystick counterclockwise causes the user to zoom out of the Ispace display and back to the map display.

Figure 2.15 Description of Map Display Menu Options

Videodisk images for maps of the world are available at five scales of resolution:

1 : 40 million
1 : 20 "
1 : 10 "
1 : 5 "
1 : 2.5 "

On entering the map display, the user views the 1:40 million world map. Each time the joystick is twisted clockwise, the user zooms into the next most detailed map. Each time the joystick is twisted counterclockwise, the user pops back to the previous, less detailed map.

Videodisk images of ONCs (Operational Navigational Charts), GNCs (Global Navigational Charts), and JNC (Jet Navigational Charts) also are available for certain parts of the world. These maps are stored on the videodisk at three scales:

1 : 800,000
1 : 400,000
1 : 200,000

If the image on the center screen is of an area that is covered by one of these smaller-scale maps, the user can zoom into the map by twisting the joystick clockwise after zooming through all the full-world maps.

The user can obtain more detailed information about a platform by touching it or by selecting it with the cursor. If the selected platform is represented on an Ispace, the user is transported out of the map display and into that Ispace. Otherwise, the user is directed to the RELATED ICONS menu item. By selecting RELATED ICONS, the user will enter the Ispace that corresponds to the platform type under consideration (ships, submarines, or aircraft). To return to the map display from an Ispace, the user twists the joystick counterclockwise.

To exit the map display and return to the TOP level, the user twists the joystick counterclockwise while viewing the least detailed map (1:40 million).

3. System Environment

SDMS consists of 50,000 lines of code written in the C language, running under the UNIX operating system. The USS Carl Vinson SDMS system is implemented on a DEC PDP-11/70.

The GDS is viewed via three Advanced Electronic Display (AED) frame buffer displays. Each display has its own 512x512x8 bit memory from which the image on the color screen is generated.

The SDMS user station consists of the following items:

- 3 19-inch color monitors with high-resolution shadow masks
- 3 Touch-sensitive digitizers
- 1 Joystick
- 1 Data tablet
- 2 MCA/Pioneer videodisk players with outboard RS232 controller/interfaces

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5. Glossary

This section contains definitions of terms used throughout the USS USS Carl Vinson SDMS documentation. Unless otherwise noted, section numbers refer to sections in this document.

Data Surface: A single, flat surface on which icons are arranged. Data surface is synonymous with image plane.

Graphical Data Space (GDS): The collection of all data surfaces, or all the graphical information that the user can access.

Icon: A picture that represents some object in the database. For instance, an icon can represent one or more tuples in a database.

Image Plane (iplane): A data surface. A representation of an information space at one level of detail. A more detailed image plane contains more detailed representations of each icon in the information space. Typically, an information space is represented at several levels of detail, to allow the effect of zooming into the icons.

Information Space (Ispace): Typically, a collection of icons that represent related data. An information space includes an image plane for the world view and one or more image planes that are viewed on the main display screen.

PAINT: SDMS's interactive system for creating and manipulating pictures on the screen.

Port: Transition point between two information spaces. Zooming into a port causes the user to pop through the current information space into another one. Ports act as trap doors into information spaces. Process ports act as trap doors to processes in the underlying computer system.

SQUEL: Spatial QUEry Language. SQUEL is the SDMS query and command language.

TOP Level: The first display the user views when he runs SDMS.

World View: The high level view of an SDMS information space that is presented on the left-hand display screen of the user station. At any given time, the world view is a less detailed or faraway view of the information on the center screen. The world view is useful for orienting one's self in a large information space and for moving quickly from one area of the data surface to another.

6. Acronyms and Abbreviations

DBMS	database management system
GDS	Graphical Data Space
ICDL	Icon Class Description Language
iplane	image plane
Ispace	Information space
SDMS	Spatial Data Management System
SQUEL	Spatial QUEry Language